# EFFECT OF PIPE DIAMETER IN PIPING SYSTEM USING ACOUSTIC EMISSION TECHNIQUE

WAN MOHAMED ASYRAF BIN WAN ZAHARI

Thesis submitted in fulfillment of the requirements
for the award of the degree of
Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

DECEMBER 2010

**UNIVERSITI MALAYSIA PAHANG**

**FACULTY OF MECHANICAL ENGINEERING**

I certify that the project entitled "*Effect of Pipe Diameter In Piping System Using Acoustic Emission Technique*" is written by *Wan Mohamed Asyraf Bin Wan Zahari*. I have examined the final copy of this project and in our opinion; it is fully adequate in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering. I herewith recommend that it be accepted in partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering.

DR YUSNITA RAHAYU

Examiner Signature

# SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion, this project is adequate in terms of scope and quality for the award of degree of Bachelor of Mechanical Engineering

Signature

Name of Supervisor: MADAM.MIMINORAZEANSUHAILA BINTI LOMAN

Position: LECTURE

Date:

## STUDENT'S DECLARATION

I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The project has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature

Name: WAN MOHAMED ASYRAF BIN WAN ZAHARI

ID Number: MA 07080

Date: $6^{th}$ DECEMBER 2010

# ACKNOWLEDGEMENT

Firstly, I would like to give a lot of grateful and thanks to Allah S.W.T for allow me to develop and complete this project smoothly. Also, I would like to thanks to my very kind and helpful project's supervisor, Madam.Miminorazeansuhaila Binti Loman for your suggestions, advice and understandable. Also you encouragement to me complete this project.

I also would like to express my appreciation to all lab coordinator that help me perform this project. Special thanks to my friends and classmate for giving me supports and advice throughout this project although they also have a project that had to be done.

Great thanks to my parents, wan Zahari B Wan Nilam and Fatimah Bt Mohamed that support me in theme of project cost and understand my situation. Finally, I want to thank all person who involve directly or indirectly in this project

Wassalam

Wan Mohamed Asyraf B Wan Zahari

Universiti Malaysia Pahang, 2010

# ABSTRACT

This project was carried out as a study of effect of pipe diameter different and different pressure in piping system by using Acoustic Emission technique. The objective of this research is to investigate the flow rate in the piping system due to the pipe diameter difference and pressure different and evaluates type of signal produce from the acoustic emission technique for each type of pipe diameter in piping systems. A test rigs consist of a galvanized steel pipe that have two different diameters to run the experiments. The liquid that has been used is water and it controlled by the ball valve to setting the three different pressures. The source of the AE signal was from the ball valve that controlled the pressure but the effect of different diameter also play it roll because it can give a different flow rate that will show either the flow of water is low or high turbulent flow. The signal was captured using AE sensor with help of Acoustic Emission Detector 2.1.3 software. For all pipe diameter and pressure, the values of hits, counts and RMS (average, minimum and maximum) were recorded and analyzed. All the value recorded was compared to the different of pipe diameter and different pressure. The result shows that there almost no AE activities on the pipe that has big diameter compare to the smaller one. The conclusion has shown that the big pipe diameter will secure the safety because of the flow of the water that enter the pipe is low in flow rate and produced low turbulent flow compare to the small pipe diameter.

# ABSTRAK

Projek ini dilakukan sebagai kajian tentang pengaruh paip diameter yang berbeza dan tekanan cecair berbeza dalam sistem perpaipan dengan menggunakan teknik Emisi Akustik. Tujuan projek ini dijalankan adalah untuk mengetahui laju aliran cecair dalam sistem perpaipan kerana perbezaan diameter paip dan tekanan berbeza dan menilai isyarat dari teknik pembebasan akustik untuk setiap jenis diameter paip dalam sistem perpaipan. Sebuah rig ujian terdiri daripada paip baja Galvanis yang memiliki dua diameter yang berbeza untuk menjalankan eksperimen. Cecair yang telah digunakan adalah air dan dikawal oleh injap bola untuk mendapat tiga tekanan yang berbeza. Sumber dari isyarat AE itu dari injap bola yang mengawal tekanan tetapi kesan diameter berbeza juga member impak kerana ia boleh memberikan kadar kelajuan cecair terapung yang berbeza yang akan menunjukkan aliran air adalah aliran turbulen rendah atau tinggi. Isyarat ini ditangkap dengan sensor AE dengan bantuan software Detektor Akustik Emisi 2.1.3. Untuk semua diameter paip dan tekanan, nilai-nilai hits, jumlah dan RMS (rata-rata, minimum dan maksimum) direkodkan dan dianalisis. Semua nilai tercatat dibandingkan dengan perbezaan diameter paip dan tekanan yang berbeza. Keputusan kajian menunjukkan bahawa hampir tidak ada kegiatan AE pada paip yang memiliki diameter besar berbanding dengan yang lebih kecil. Kesimpulannya telah menunjukkan bahawa diameter paip besar akan menjamin keselamatan kerana aliran air yang masuk ke paip adalah rendah dan menghasilkan aliran turbulen rendah berbanding dengan diameter paip kecil.

# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# LIST OF ABBREVIATIONS

| | |
|---|---|
| AE | Acoustic Emission |
| AD | Analog to digital |
| D/A | Digital to analog |
| NDE | Non destructive evaluation |
| NDT | Non destructive testing |
| PC | Personal computer |
| RMS | Root mean square |
| TFE | Teflon |

# LIST OF SYMBOL

| | |
|---|---|
| A | Area |
| $C_V$ | Flow coefficient |
| D | Diameter |
| D | Pipe diameter |
| $l_e$ | Entry length |
| ρ | Density |
| Q | Flow rate |
| $R_e$ | Reynolds Number |
| μ | Fluid viscosity |
| V | Flow velocity |

# CHAPTER 1

# INTRODUCTION

## 1.1 THE OBJECTIVE OF PROJECT

The objective of this research is to investigate the flow rate in the piping system due to the pipe diameter difference and evaluates type of signal produce from the acoustic emission technique for each type of pipe diameter in piping systems. The effect will be seen in the type of the flow rate that was produced by changing the diameter of the pipe in the piping system and the pressure that was divided between low and high pressure (psi). Then, classify the signal and effect on the pipe diameter and choose the suitable diameter for the difference pressure that was choice.

## 1.2 SCOPE OF PROJECT

This focus is based on the following aspect:

i) Perform the entire experimental indicator such, a set of piping system and other.

ii) Capture the signal produced due to the flow rate that is produce by using different pipe diameter and difference pressure.

iii) The material of the piping system may be made of galvanized iron (Gi).

iv) Galvanized iron (Gi).In this project we prefer to use Galvanized iron (Gi). Because easy to get and widely used in plumbing work.

v) The element that was carried was liquid (water).

## 1.3 PROBLEM STATEMENT

Existing piping system may cause a several defect cause by the flow rate, type of fluid carried and the pressure. This defect may decrease the efficiency of the piping system. Some theory was related to the cause of the defect such as the diameter of the pipe, valve that controls the pressure and type of pipe material. Hence, this project is focus on the pipe diameter and the different of pressure by catch the signal produce by the piping system during the flow process. The equipment that uses to catch the signal is Acoustic Emission devices. This signal was interpret to find the conclusion about the effect of pipe diameter to the piping system.

## 1.4 PROJECT BACKGROUND

Pipe system was one of reliable, effective and safer system to transfer matter or energy. Varieties of materials were use to made a pipe system depend on the type of element that wants to transfer but major of it made of metal. Pipe systems are one of the most reliable and safest means of transfer of matter and energy. Now, because of high demand in the pipe system so many inventors have replaced metal with new material such as plastic products and composites that enhanced the domain of application of material systems in pipelines. Plastic pipes have salient features such as low weight, ease of connection and corrosion resistance. It was cheaper too compare to other material, but it can't hold high pressure and temperature so it only suitable to used for simple liquid transfer that have moderate pressure and temperature. Galvanized iron (Gi) was widely used in the plumbing work to carried liquid such as water and oil. It's cheaper than other metal pipe that used. Galvanized iron (Gi) Pipe is black steel pipe which has been hot dip galvanized. GI pipes are available in three grades depending on the thickness of the sheet used in the pipe. In certain sector such as water supply, power generates and etc, the length of piping system can be hundreds meters or kilometers so along the piping system there can be various of failure modes including crazing, cracking, large deformation, buckling, fracture, local damage, corrosion and clogging of piping system. Piping system also has lot of diameters that need to be concern and researches depend on the element that was carried and the effectiveness to achieve the destination. The effect of pipe diameter of piping system should taking serious to make sure transfer of element and energy smoothly and also avoid failure occur at the pipeline. Hopefully this research can expand inventive concept to understand the effective diameter in piping system affected.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 ACOUSTIC EMISSION (AE)

### 2.1.1 BRIEFING HISTORY OF AE

Although acoustic emissions can be created in a controlled environment, they can also occur naturally. Therefore, as a means of quality control, the origin of AE is hard to pinpoint. As early as 6,500 BC, potters (Figure 2.1) were known to listen for audible sounds during the cooling of their ceramics, signifying structural failure. In metal working, the term "tin cry" (audible emissions produced by the mechanical twinning of pure tin during plastic deformation) was coined around 3,700 BC by tin smelters in Asia Minor. The first documented observations of AE appear to have been made in the 8th century by Arabian alchemist Jabir ibn Hayyan. In a book, Hayyan wrote that Jupiter (tin) gives off a ‘harsh sound’ when worked, while Mars (iron) ‘sounds much’ during forging.

**Figure 2.1:** Potters.

Source: Ndt Resource center, 2001

Many texts in the late 19th century referred to the audible emissions made by materials such as tin, iron, cadmium and zinc. One noteworthy correlation between different metals and their acoustic emissions came from Czochralski, who witnessed the relationship between tin and zinc cry and twinning. Later, Albert Portevin and Francois Le Chatelier observed AE emissions from a stressed Al-Cu-Mn (Aluminum-Copper-Manganese) alloy.

The next 20 years brought further verification with the work of Robert Anderson (tensile testing of an aluminum alloy beyond its yield point), Erich Scheil (linked the formation of martensite in steel to audible noise), and Friedrich Forster, who with Scheil related an audible noise to the formation of martensite in high-nickel steel. Experimentation continued throughout the mid-1900's, culminating in the PhD thesis written by Joseph Kaiser entitled "Results and Conclusions from Measurements of Sound in Metallic Materials under Tensile Stress." Soon after becoming aware of Kaiser's efforts, Bradford Schofield initiated the first research program in the United States to look at the materials engineering applications of AE. Fittingly, Kaiser's research is generally recognized as the beginning of modern day acoustic emission testing. (Ndt Resource center, 2001)

### 2.1.2 BRIEFING INTRODUCTION OF AE

The acoustic-emission technology has been applied widely in industries, educational centre, medical field and certain organization to used as non-destructive inspection(NDI) or non-destructive testing(NDT) and technical diagnostic of industrial objects such as pipelines and pressure vessels, tanks, heat exchangers, bridges, cranes and other metallically structures. The latest acoustic –emission system has a multichannel and multifunction system that was build on the basis of personal computers. Acoustic technique is widespread among the methods of engineering diagnosis used nowadays to assess the state of machines and mechanism comprising rotating parts and movable joints. Potters observed the sound emanating from the pots while tapping to ascertain the soundness of the vessel as the cracking sound emitted by tin during deformation (also called as 'tin cry') is probably the first true acoustic emission techniques heard from metal.There are a lot of advantages using this technique compare to other:

i. Compactness and small weight of instrumentation,
ii. Small consumed power and capability of battery backup,
iii. Presence of the built-in uninterruptible power supply,
iv. The expanded temperature range of operation of instrumentation,
v. Hardening of instrumentation from effect of shocks, moisture and dust.
vi. Reliability, ease and convenience in usage.
vii. Ensure quality levels.
viii. Ensure customer satisfaction.
ix. Predicts impending failures, thus preventing costly shutdowns and aids in plant life extension.
x. Aids in optimum product design.

*NDT or NDI is the technology of assessing the soundness and acceptability of a material, component or structure without impairing its functional properties or ‘worth’ the term “NDT” includes many method that can detect:

- Detect surface or subsurface imperfections.
- Determines structure, composition or material properties.
- Measure geometric characteristics.

Examples include detecting and locating faults in pressure vessels, damage assessment in fibre-reinforced polymer-matrix composites, monitoring welding applications and corrosion processes, various process monitoring applications, global or local long-term monitoring of civil-engineering structures (e.g., bridges, pipelines, offshore platforms, etc.) and fault detection in rotating elements and reciprocating machines, to name but a few.

The scientific application of AE first emerged in the 1950's, but the decline of heavy industry, nuclear power and defense spending in the 1980s, together with some poor publicity, resulted in a quiet period for AE research. Nevertheless the technique has developed significantly and emerged as a very powerful method for numerous measurement problems, far beyond conventional non-destructive testing.

Today there is a transition to waveform-based analysis, which has opened up a new approach to AE analysis. Recent successes have been largely due to advances in high-speed digital waveform based AE instrumentation, improvements in high fidelity, high sensitivity broadband sensors and advanced PC-based signal analysis. This has given researchers an enhanced understanding of AE signal propagation, enabling a departure from traditional reliance on statistical analysis, significantly improving the monitoring capabilities of AE.

New developments have raised new problems, not least of which is sensor technology. Resonant transducers are useful in many applications but increasingly are replaced by sensors with broader frequency characteristics. Issues of flat response, sensitivity and calibration need to be addressed. Modern data transfer methods such as network techniques and wireless communication ensure that AE technology will be a field of interesting future developments and applications. (Ndt Resource center, 2001)

## 2.2 THEORY AE SOURCES

As mentioned in the Introduction, acoustic emissions can result from the initiation and growth of cracks, slip and dislocation movements, twinning, or phase transformations in metals. In any case, AE’s originate with stress. When a stress is exerted on a material, a strain in induced in the material as well. Depending on the magnitude of the stress and the properties of the material, an object may return to its original dimensions or be permanently deformed after the stress is removed. These two conditions are known as elastic and plastic deformation, respectively.

The most detectible acoustic emissions take place when a loaded material undergoes plastic deformation or when a material is loaded at or near its yield stress. On the microscopic level, as plastic deformation occurs, atomic planes slip past each other through the movement of dislocations. These atomic-scale deformations release